SENTINEL SURVEILLANCE METHOD

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1. Description of Method

Sentinel surveillance provides an alternative to population-based surveillance for the collection and analysis of individual patient-related information and more limited monitoring of antimicrobial resistance trends. A principal advantage of a sentinel laboratory system, compared with the antibiogram method for example, is the ability to collect information on individual cases. For example, sentinel surveillance allows for comparison of trends in resistance among pediatric cases, adult cases, between age groups or among individual patients from whom *S. pneumoniae* is isolated.

The sentinel surveillance method utilizes fewer required resources by reducing the number of potential hospital and laboratory reporting facilities within the general, larger surveillance area that may elect to participate in the surveillance network.

Findings from sentinel data collection are useful for documenting trends but are not population-based. Sentinel surveillance may detect the proportion of resistance and epidemiologic characteristics of *S. pneumoniae* within the laboratory sentinel surveillance network. However, it is not possible to calculate the disease incidence rate with this method. Additionally, it is important to remember with sentinel surveillance, results are not representative of the entire population and the potential for sampling biases exist.

Unlike population-based surveillance, sentinel surveillance does offer greater design flexibility with participation requirements of various network partners. The surveillance system may be passive, with data collection and reporting initiation being completely reliant upon the willingness of hospital and laboratory personnel within each reporting facility. Also, depending upon the goals and intended uses of surveillance data, the option to collect isolates or simply collect susceptibility results from reporting laboratories adds additional design flexibility for state personnel. State health personnel may elect to collect all invasive pneumococcal isolates from normally sterile body sites, along with patient demographic and clinical information in order to monitor vaccine use and efficacy or increase capacity for additional susceptibility testing and serotyping.

On the other hand, state health personnel may elect to pursue a less burdensome protocol of requesting only the susceptibility testing results of invasive isolates from participating laboratories. Although this option requires less personnel time and resources, its analysis limitations include no availability of serotype information, and susceptibility results are limited to only those drugs tested by hospital laboratories.

Sentinel Surveillance Method Overview

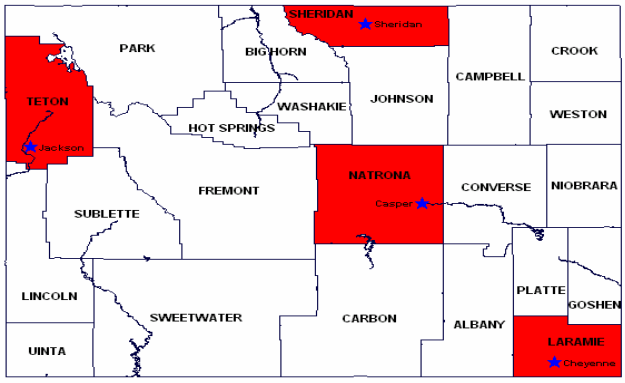
System Definition	Key Advantages	Key Disadvantages
Limited case ascertainment area Surveillance network comprised of selected hospitals and laboratories out of all possible hospitals/laboratories in surveillance area Traditionally includes largest hospitals in geographic area Should do pre-evaluation to select appropriate sentinel sites	Can easily collect individual patient-related data Less costly and burdensome on resources Flexible system design Useful for documenting trends Allows for routine monitoring of antibiotic non-susceptibility	Although less costly than population-based surveillance, sentinel system may still require significant financial investments in personnel and resources Data may have biased or skewed findings Data is not generalizable to geographic population This method does <u>not</u> collect incidence data

Current Models Currently, there are several examples of well-designed and implemented state-based sentinel surveillance programs in the United States. Two state-based sentinel models were presented at *CDC's Drug-Resistant* Streptococcus pneumoniae *and Methicillin-Resistant* Staphylococcus aureus *Surveillance Conference* in March 2003 (1). These models illustrate the design flexibility between passive collection and active data collection, as well as the ability to conduct isolate collection or simply collect susceptibility testing results, that is offered by sentinel surveillance.

Wyoming's sentinel network was developed in 2000 to monitor Drug-Resistant *Streptococcus pneumoniae* (DRSP). State surveillance officers wanted to capture *S. pneumoniae* resistant and non-susceptible data for two specific antibiotics, penicillin and cefotaxime. The data collection goals in Wyoming were: 1) to obtain data so that they could calculate the rate of resistance, 2) to receive more complete data than previously obtained from passive surveillance, and 3) to collect local data that could be used as a means of drawing an "in our backyard picture" for prevention and control efforts. State health officials developed a sentinel network of participants to collect and report data, and in which analysis could achieve these program goals.

As of 2002, the system had 4 reporting sites. The selection of these sites was based on geographic location, level of laboratory capacity, willingness to participate and relationship to outlying tertiary care facilities. All four hospitals serve as referral centers for Wyoming's dispersed rural communities and consequently capture data from both major cities and rural areas. All laboratories routinely report data regarding presence of invasive disease, resistance to penicillin and resistance to cefotaxime. Wyoming surveillance personnel communicate routinely with reporting facilities and have realized improved reporting consistency and completeness of data since communication has increased.

Wyoming Sentinel Surveillance System's Participating Laboratories



Wyoming's sentinel surveillance system is in its third year of data collection and state surveillance personnel report the benefits of implementing this system have included: 1) the ability to calculate proportion of resistance for multi-year comparisons is more useful than reported case numbers and, 2) the reliance on active versus passive data collection has resulted in more complete data collected from selected laboratories.

Washington State presented a second state sentinel surveillance system at the CDC conference. Their sentinel network was formed in 1997 and state health personnel were able to share experiences and lessons learned from their six year history. Washington State formed their sentinel network in order to collect data that described the prevalence of resistance and to assist in directing control efforts. Personnel identified 41 hospitals and tertiary pediatric centers that meet eligibility requirements for participation and 27 (66%) of the hospitals agreed to participate (2). Infection control practitioners at participating hospitals identified *S. pneumoniae* isolated from either blood or cerebrospinal fluid that was submitted to laboratories for susceptibility testing. For each

isolate, patient demographic information was collected and submitted quarterly to the state health department (3). Reported information included: age, sex, date of specimen collection, collection site, antibiotics tested, methods used (i.e., disk diffusion, agar dilution, antimicrobial gradient strips, or broth dilution), numeric results (MIC value), and interpretations of MIC testing (i.e., S,I,R). Letters were sent to network participants each quarter to encourage reporting.

Initially, the surveillance teams in Washington State had a positive response to the establishment of the sentinel surveillance network. They found a considerable increase in penicillin non-susceptibility over previous survey data. Feedback to network participants led to use of improved susceptibility testing methods by laboratory personnel. State health personnel deemed the voluntary reporting network to be an effective alternative to mandated statewide reporting.

However, Washington State found that network reporting participation and the number of centers willing to participate gradually declined after the first year of implementation.

Washington State Participation Declines with Passive Reporting
Pneumococcal Case (4)

YEAR	FACILITIES	CASES
1997 (partial)	**27**	**166**
1998	**21**	**280**
1999	**15**	**192**
2000	**6**	**92**
2001	**5**	**70**

In order to improve the reporting and participation levels of the surveillance network, Washington State conducted a survey to assess participants' willingness and feasibility. Feedback provided insights that led to several amendments to the reporting requirements to facilitate and encourage participation. Some of the changes included more choices in communication, including adding email or fax as a means of reporting results and taking greater advantage of existing data such as antibiograms generated by each reporting facility. The reporting forms were revised and simplified. Reporting intervals were lengthened to semi-annual from the previous quarterly requirement. Most significantly, reporting facilities were allowed to select from three levels of reporting requirements they were willing to participate in, depending upon the degree of difficulty and additional workload on personnel (i.e., antibiograms, semi-annual isolate submissions, case reporting with antibiotic susceptibilities.)

Washington State personnel shared with conference participants four key lessons learned from their sentinel surveillance experience.

- Individualize communications
- Re-request data each interval
- Know your reporters
- Time and attention to communication is required

2. Required Resources

Participating Sites Site selection is often not a random process, but may be determined by practical considerations such as which sites are willing and capable of

participating at the required level. Two major considerations for eligibility include *adequate laboratory capacity to perform the appropriate tests* and *appropriate sample size in collecting a minimum number of isolates*. As the number of participants increases, so does the predictive accuracy when comparing testing results to a "gold standard" (5).

The ability of a sentinel system to detect a trend in the larger population will depend upon the types of the participating sites included in the surveillance model (5). Children are a primary reservoir of *S. pneumoniae* and because the incidence of invasive pneumococcal disease is elevated in children compared to the rest of the population, states may sometimes choose to include children's hospitals in sentinel surveillance systems as a way of increasing their likelihood of identifying resistance problems. However to track trends in resistance to drugs that are not indicated for use in children, such as fluoroquinolones, children's hospitals may not be reliable indicators.

Surveillance Protocol and Case Report Form Similar to population-based surveillance, sentinel sites are required to apply a standardized case definition for disease classification. Participating sites also follow a standardized protocol for isolate collection, if isolate collection is required, and testing using NCCLS performance standards and reporting susceptibility results following established guidelines.

Designing a one-page case report form that is simple to use, and can be easily faxed or mailed, is advantageous to achieving consistent and complete reporting. Recommended information included on a case report form includes basic patient demographic and

disease specific (i.e., isolate date and source) information, laboratory name, MIC method used, testing results with definitions of "non-susceptible" or "high-level resistance" and actual MICs. Once information is recorded on a case report form, it can easily be forward to the appropriate state health surveillance officer. Bacterial isolates extracted from normally sterile sites can be sent to the laboratory for confirmation, if included in the site's protocol.

Epidemiology and Laboratory Personnel

To accurately track the burden of *S. pneumoniae* using a sentinel laboratory network, a surveillance coordinator at each laboratory is required. The volume of work associated with this position's responsibilities may not require one full-time surveillance coordinator (i.e., one F.T.E.); thus possibly allowing this position to assume duties with other surveillance programs or assume related prevention and control activities (i.e., health communications activities). The actual time required will depend upon the design and size of the sentinel network, characteristics unique to each state. Job requirements of the surveillance position include, but are not limited, to the following activities:

- Coordinate the routine surveillance area activities as directed by the surveillance process and protocol
- Ensure that epidemiologic data is collected on standardized reporting forms, is correctly entered on the forms, and complete
- Coordinate the collection and transport of isolates for laboratory testing, if required by protocol.

- Ensure that communication among all surveillance sites is timely, accurate, and complete
- In some settings, a surveillance coordinator will aggregate data and generate reports

Because case findings are laboratory-based, the laboratories in acute care hospitals and appropriate reference laboratories process the isolates and case report forms. Additionally, the infection control or clinical staff collects individual patient information. This requires continuous training and monitoring of laboratory personnel to ensure adherence to the surveillance protocol. Transporting isolates from the collection site to centralized laboratory testing facilities requires coordination of logistics and personnel time.

Data Management Requirements As with population-based surveillance, sentinel surveillance requires a central repository for data collection at the state or county-level. Use of a software package such as Access, Epi-info or Excel, which is easily transmitted and shared among sites is necessary, can facilitate the timely exchange of data. Alternately, a data base can be maintained in one place with forms faxed, mailed or emailed in. Since the purpose of sentinel surveillance is to capture data using a subset of reporting facilities within a geographic area, the network area under sentinel surveillance will generally not include as large of a population area as population-based surveillance. Consequently, the data repository capacity for sentinel surveillance will not be required to be as large. However, similar skills, such as knowledge of data base software and statistical analysis abilities are required. Depending upon the surveillance network's size

and surveillance goals, the data management position does not necessarily require a full-time employee for the successful completion of monthly requirements. In some settings, these duties can be included in the surveillance officer's overall responsibilities.

3. System's Level of Precision

Reports have suggested that sentinel networks may provide a more accurate profile of community resistance patterns than antiobiogram screening since antibiogram data may include non-sterile isolates as well as multiple isolates from a single patient that may disproportionately influence the results. However, a sentinel system is not a useful surveillance mode for detecting newly emerging resistance trends or rare events (5). Since sentinel surveillance networks are comprised of a subset of the larger number of hospitals or laboratories, it is important to remember that a biased look may overestimate or underestimate "true" resistance patterns. However, trends over time in uniform/consistent sites can provide insights into potential antibiotic resistance trends. State health professionals need to be aware of potential biases as they draw conclusions from collected data or implement new programs based on the data.

4. Information Gained

States may address a variety of local needs by collecting resistance data. Local data may reflect resistance trends, and may be more useful than national data for raising awareness of the problem of antimicrobial resistance. It can also provide a local picture of resistance trends that are helpful in developing and driving local health education and antibiotic resistance prevention campaigns. It is appropriate to use this data to guide and

evaluate locally implemented programs. However, local data are generally not optimal sources of information to contribute to the development of clinical guidelines for the management of pneumococcal disease, vaccine development or guide national reporting requirements.

Baseline information on isolates processed annually per laboratory and between-laboratory variability can be used to predict how well the sentinel system is performing. Data can also be used to evaluate the completeness and timeliness of reporting. Information may be collected retrospectively or prospectively from microbiology laboratories (5). If states detect high between-laboratory variability or few isolates per laboratory, relative to the patient population served, health officials may want to consider integrating sentinel surveillance with another method to complement the data collection.

In some cases, additional surveillance methods may be critical for capturing unusual but important resistance events. For example, sentinel surveillance combined with universal reporting of fluoroquinolone- or vancomycin-resistant pneumococci will help detect important new resistance patterns before they become widespread. Additionally, states may want to collect isolates from a few sentinel laboratories for repeat susceptibility testing using a more diverse drug panel than is typically used in most clinical microbiology laboratories (5).

5. Key Advantages

Whether the stated goals include identifying the molecular epidemiologic pattern for isolates causing invasive infections, detecting the proportion resistant and epidemiologic characteristics of *S. pneumoniae*, tracking emerging antimicrobial resistance and evaluating the efficacy of new pneumococcal conjugate vaccines for infants and pneumococcal polysaccharide vaccine use among the elderly, sentinel surveillance methods provide a feasible option for data collection tracking disease trends, and monitoring the prevalence of drug resistance. A principal advantage of a sentinel laboratory system, compared with the antibiogram method for example, is the ability to collect information on individual cases. For example, sentinel surveillance could allow for comparison of trends in resistance among pediatric cases, adult cases, between age groups or among individual patients from whom *S. pneumoniae* is isolated.

Sentinel systems may be active or passive based upon personnel resources and financial considerations, thus allowing a degree of flexibility in design and implementation. A sentinel system's flexibility allows for a greater range of programmatic goals and anticipated uses of the data. Sentinel networks potentially provide value to states beyond the data collected. These include (1) partnerships built between participating health care centers, (2) buy-in and participation among the reporting facilities, (3) awareness of overall DRSP trends and antibiotic use messaged, (4) increased awareness of the association between pneumococcal vaccination and occurrence of preventable disease, (5) opportunities for clinical laboratory evaluations, feedback and (6) coordination and communication between historically separate institutions. Sentinel systems have more

flexibility and lower costs, compared to population-based surveillance, therefore, providing a cost-effective option for health departments interested in pursuing laboratory-based surveillance. Relying upon fewer participating facilities to monitor community disease trends requires a smaller financial outlay of limited resources, personnel and laboratory capacity.

6. Key Disadvantages

Despite its advantages, sentinel surveillance does have certain significant limitations. The system, depending upon design, can require a substantial investment in financial and human resources, laboratory personnel, training, coordination and logistics coordination. Collection, transport and testing of isolates, if done, may require a large proportion of laboratory personnel's' time. In order for sentinel systems to work most efficiently and accurately, communication must be consistent among participants.

7. Goals Best Met By a Sentinel Surveillance System

Sentinel surveillance is a feasible option for health departments with goals that focus on obtaining some trend data. Schrag, et al. evaluated the validity of the sentinel method in assessing (1) ability of small groups (varying in groups of 3, 4, and 5) of selected laboratories to accurately estimate the prevalence of resistance as a whole, (2) whether small groups of sentinel laboratories accurately tracked changes in the proportion of DRSP over time, (3) whether small groups of sentinel laboratories could detect newly emerging resistance profiles, and (4) whether hospital characteristics could be used to guide selection of laboratories included in the system.

The study concluded that sentinel surveillance for resistant pneumococci can detect important trends over time, but rarely detects newly emerging resistance profiles. Increasing the number of participating laboratories improved accuracy, but no hospital characteristics were identified as useful predictors to indicate a combination of laboratories that would produce the most valid results. Sentinel laboratory groups were most reliable at detecting large increases or decreases in the proportion of nonsusceptible invasive isolates over time (5).

References

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